

Precipitation Estimation Using Combined Radar/Radiometer Measurements Within the GPM Framework

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Abstract

The Global Precipitation Measurement (GPM) Mission is an international satellite mission specifically designed to unify and advance precipitation measurements from a constellation of research and operational microwave sensors. The GPM mission centers upon the deployment of a Core Observatory in a 65° non-Sun-synchronous orbit to serve as a physics observatory and a transfer standard for inter-satellite calibration of constellation radiometers. The GPM Core Observatory will carry a Ku/Ka-band Dual-frequency Precipitation Radar (DPR) and a conical-scanning multi-channel (10-183 GHz) GPM Microwave Radiometer (GMI). The DPR will be the first dual-frequency radar in space to provide not only measurements of 3-D precipitation structures but also quantitative information on microphysical properties of precipitating particles needed for improving precipitation retrievals from microwave sensors. The DPR and GMI measurements will together provide a database that relates vertical hydrometeor profiles to multi-frequency microwave radiances over a variety of environmental conditions across the globe. This combined database will be used as a common transfer standard for improving the accuracy and consistency of precipitation retrievals from all constellation radiometers.

For global coverage, GPM relies on existing satellite programs and new mission opportunities from a consortium of partners through bilateral agreements with either NASA or JAXA. Each constellation member may have its unique scientific or operational objectives but contributes microwave observations to GPM for the generation and dissemination of unified global precipitation data products. In addition to the DPR and GMI on the Core Observatory, the baseline GPM constellation consists of the following sensors: (1) Special Sensor Microwave Imager/Sounder (SSMIS) instruments on the U.S. Defense Meteorological Satellite Program (DMSP) satellites, (2) the Advanced Microwave Scanning Radiometer-2 (AMSR-2) on the GCOM-W1 satellite of JAXA, (3) the Multi-Frequency Microwave Scanning Radiometer (MADRAS) and the multi-channel microwave humidity sounder (SAPHIR) on the French-Indian Megha-Tropiques satellite, (4) the Microwave Humidity Sounder (MHS) on the National Oceanic and Atmospheric Administration (NOAA)-19, (5) MHS instruments on MetOp satellites launched by the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), (6) the Advanced Technology Microwave Sounder (ATMS) on the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP), and (7) ATMS instruments on the NOAA-NASA Joint Polar Satellite System (JPSS) satellites. Data from Chinese and Russian microwave radiometers may also become available through international collaboration under the auspices of the Committee on Earth Observation Satellites (CEOS) and Group on Earth Observations (GEO).

The current generation of global rainfall products combines observations from a network of uncoordinated satellite missions using a variety of merging techniques. GPM' will provide "next-generation" precipitation products characterized by: (1) more accurate instantaneous precipitation estimate (especially for light rain and cold-season solid precipitation), (2) intercalibrated microwave brightness temperatures from constellation radiometers within a consistent framework, and (3) unified precipitation retrievals from constellation radiometers using a common *a priori* hydrometeor database constrained by combined radar/radiometer measurements provided by the GPM Core Observatory.

GPM is a science mission with integrated applications goals. GPM will provide a key measurement to improve understanding of global water cycle variability and freshwater availability in a changing climate. The DPR and GMI measurements will offer insights into 3-dimensional structures of hurricanes and midlatitude storms, microphysical properties of precipitating particles, and latent heat associated with

precipitation processes. The GPM mission will also make data available in near realtime (within 3 hours of observations) for societal applications ranging from position fixes of storm centers, numerical weather prediction, flood forecasting, freshwater management, landslide warning, crop prediction, to tracking of water-borne diseases.

An overview of the GPM mission concept, retrieval strategy, ground validation activities, and international science collaborations will be presented.